

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
3 October 2002 (03.10.2002)

PCT

(10) International Publication Number
WO 02/076562 A1

(51) International Patent Classification⁷: **A63C 19/06, 19/08**

(21) International Application Number: **PCT/AU02/00357**

(22) International Filing Date: **25 March 2002 (25.03.2002)**

(25) Filing Language: **English**

(26) Publication Language: **English**

(30) Priority Data:
PR 3965 26 March 2001 (26.03.2001) AU

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(81) Designated States (national): **AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.**

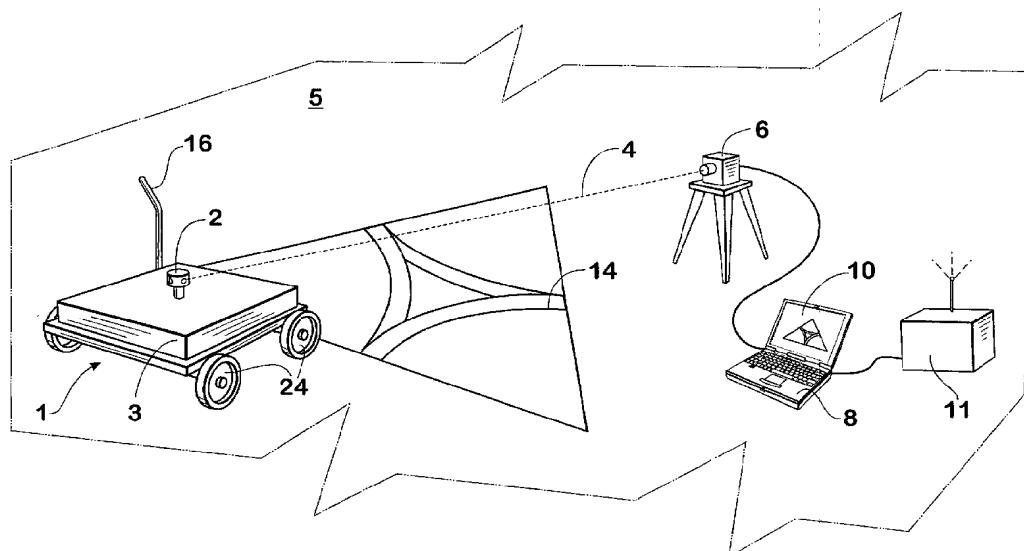
(84) Designated States (regional): **ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).**

Published:

— with international search report

[Continued on next page]

(54) Title: AUTOMATIC GROUND MARKING METHOD AND APPARATUS



(57) Abstract: An automatic ground marking apparatus including a carriage (1) responsive to carriage control signals for traversing the ground (5), the carriage having a controllable steering and drive system, a controllable marking system and a position determining system (6) arranged to determine the position of the carriage. The ground marking apparatus further includes a processor (8) responsive to the position determining system and operatively executing a software product for generating said carriage control signals to cause the carriage (1) to mark out a predetermined sign (14) on the ground. The position determining system (6) suitably employs a laser beam (4) and reflective tracking prism (2), and the predetermined sign may be defined by data points stored in a file (9) accessed by the processor (8).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

TITLE

AUTOMATIC GROUND MARKING METHOD AND APPARATUS

BACKGROUND OF THE INVENTION

5 Field of the Invention

The present invention relates to an apparatus and method for making markings on ground surfaces such as turf playing fields and fairways. The invention has particular although not exclusive application where there is a need to automatically produce signs, such as logos or advertisements for example, on large 10 ground surfaces whether even, sloped or undulating.

Discussion of the Background Art

A variety of arrangements for marking turf, such as the turf of playing fields, are known in the prior art. The simplest turf marking involves the application of 15 straight lines to demarcate playing field boundaries. Commercially available line marking machines are used to facilitate such marking. Such machines may include a line of sight guide to aid the operator in producing a straight line between two reference points. Line marking machines are not suitable for producing complex signs or logos on turf.

20 Over the last two decades there has been a trend to mark playing fields with signs such as corporate logos or advertisements. High profile sporting events attract large crowds and television coverage so that turf advertisements are effective as such events are viewed by a large audience.

One way in which signs have traditionally been produced on turf has been with 25 the help of stencils having apertures through which paint is sprayed or otherwise applied. The production and application of stencils for creating complex and large turf markings is time consuming and prone to error.

The surface of grounds such as sporting fields typically include variations in 30 surface level, such as for drainage purposes. These variations can vary from tens of centimetres and upwards across conventional sporting fields. Large variations or undulations can cause distortion of logos and possibly affect viewing by spectators. On a golf course there are deliberate variations and undulations in ground surfaces, which exacerbate problems with application and viewing of ground markings.

Hitherto it has not been widely known to automatically apply complex markings to ground surfaces, especially to turf which is non-planar, undulating or uneven, since neither of the previously discussed approaches to the generation of turf markings are particularly suited to application on a non-planar or sloping surface.

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SUMMARY OF THE INVENTION

Object of the Invention

It is an object of the present invention to provide methods and apparatus that are an improvement over presently available methods and apparatus for marking ground surfaces with designs such as corporate logos.

It is an object of certain embodiments of the invention to provide methods and apparatus for automatically and efficiently marking level/even or undulating/uneven turf with complex patterns or logos.

15 Disclosure of the Invention

According to a first aspect of the invention there is provided an automatic ground marking apparatus including:

a carriage responsive to carriage control signals for traversing the ground, the carriage having a controllable steering and drive system and a controllable marking system;

a position determining system arranged to determine the position of the carriage; and

a processor responsive to the position determining system and operatively executing a software product for generating said carriage control signals to cause the carriage to mark out a predetermined sign on the ground.

In the present specification, the term "position" includes position of an object in three dimensional (3D) space, including the latitude, longitude and height of the object relative to a predetermined point of reference.

If required, the carriage control signals are transmitted to the carriage from a remote processor, which processor is associated with points defining the predetermined sign.

Preferably the position determining system comprises a laser based electronic distance measuring system including a base station and a reflector.

In one embodiment the base station is mounted to the carriage. In this embodiment the processor is also mounted to the carriage and connected to receive position data from the base station.

5 In an alternative embodiment the base station is fixed to the ground and the reflector is mounted to the carriage.

In that event the processor is connected to receive position data from the base station, the marking system further including a radio link to relay carriage control signals to the carriage.

10 The controllable steering and drive system may incorporate an on-board compass with further processing apparatus responsive to the compass and arranged to determine an actual bearing of the carriage.

Preferably the further processing apparatus compares the actual bearing with a desired bearing encoded in the guidance signals transmitted.

The desired bearing is typically generated by the carriage guidance system.

15 As an alternative to the laser based electronic distance measuring system, the carriage guidance system may instead include a GPS receiver.

Preferably the controllable marking system includes a reservoir for a marking medium, such as paint, and a dispensing nozzle. A controllable valve may interconnect the reservoir and dispensing nozzle.

20 The controllable steering and drive system may include a number of independently controllable drive units each coupled to a corresponding wheel of the carriage.

The carriage may further include a feedback sensor arranged to provide a feedback signal to the processor.

25 The feedback sensor may be a shaft encoder, an inclinometer or a compass.

Where the processor is located external of the carriage, a convenient way in which the feedback signal may be relayed to the processor is by means of a radio link.

30 According to a further aspect of the present invention there is provided a computer software product stored on a computer readable memory and executable by a processor for causing a carriage including a controllable steering and drive system and a controllable marking system to mark out a sign the software product including:

carriage position instructions for reading a carriage position from a data stream generated by a position sensing device;

sign point instructions for reading a file of points defining a predetermined sign;

- 5 command instructions for generating commands to cause a carriage to dispense paint on a surface in order to mark out said sign.

In another aspect of the present invention there is provided a method for surveying an area by means of an automated carriage arranged to move over a predetermined path, the method comprising the steps of:

- 10 initiating movement of the carriage over the path;
monitoring the position of the carriage; and
recording position coordinates of the carriage in a computer file.

Preferably the step of monitoring the position of the carriage is achieved by means of an EDM system at a remote site, wherein a reflective portion of said system
15 is mounted on the carriage and wherein the base station of the EDM system is at least part of the remote site. Alternatively, the EDM system may be on-board the carriage and arranged for interaction with remote reflectors.

BRIEF DETAILS OF THE DRAWINGS

- 20 In order that this invention may be readily understood and put into practical effect, reference will be made to the accompanying drawings wherein:

FIG. 1 depicts an automated turf-marking carriage according to one embodiment of the present invention;

- 25 FIG. 2 is a top plan view of the layout of the carriage of FIG. 1 with top cover removed;

FIG. 3 is a rear elevational view of the carriage of FIG. 2;

FIG. 4 is a flow chart of the steps implemented by a software product used in an embodiment of the present invention;

FIG. 5 is a flow chart showing the flow of data through the system of FIG. 1;

- 30 FIG. 6 depicts an automated turf-marking carriage according to a further embodiment of the present invention; and

FIG. 7 depicts an undulating turfed surface upon which a sign has been marked.

DESCRIPTION OF PREFERRED EMBODIMENTS

A preferred embodiment of an automatic turf marking system of the invention will be described in overview with reference to FIG. 1. A manoeuvrable paint dispensing carriage 1 for traversing the ground 5 includes a reflective tracking prism

- 5 2. A cover 3 covers the internal components of the carriage. An electronic distance measuring (EDM) base station 6 tracks the location of the carriage 1 by reflecting a laser beam 4 off the tracking prism. The base station 6 and prism 2 may be obtained as components of an AP-I1A auto-tracking electronic distance measuring system available from Topcon America Corporation of 37 West Century Road, Paramus,
- 10 New Jersey 07652, USA.

A lap-top computer 8 is coupled to a digital position data port on the base station 6. As will be explained, the computer 8 includes a processor that executes a software product that compares position data from the base station with a pre-stored data file. The data file contains coordinate points defining a desired sign or logo to

- 15 be applied to the turf. The software product may be configured to cause the computer 8 to display the desired logo on a display screen 10. Under control of the software product, the processor generates a series of steering and paint dispensing instructions that are output to a radio transmitter 11. The radio transmitter 11 transmits corresponding radio control signals to the carriage 1 for reception by an
- 20 antenna 16. The carriage receives the radio control signals and moves and releases paint in accordance with the control signals in order to mark out turf logo 14.

It is not necessary for the entire turf logo to be marked out by carriage 1. For example the software program may be configured so that the carriage marks out a number of points sufficient for a manual operator to complete the turf logo by hand.

- 25 In the presently described embodiment, the EDM base station 6, processor (in the form of the lap-top computer 8) and transmitter form a carriage guidance or position determining system. Although the EDM base station is coupled to the lap-top computer by a cable link in the drawings, it will be appreciated that the base station may be remotely controlled using radio link therebetween.

30 Referring now to FIG. 2 there is depicted a plan view of the module layout of carriage 1 with cover 3 removed. The carriage includes an antenna 16 coupled to a receiver 15 which in turn is coupled to a control module 20. Also included are

batteries 18A, 18B which provide power for the receiver 15, the control module 20, drive and steering modules 22A-22D, a pump 27 and a solenoid actuated valve 26.

The control module sends command signals to drive and steering modules 22A-22D each of which are coupled to wheels 24A-24D respectively by axle shafts 5 25A-25D. As will be explained, shaft encoders may be employed to confirm that the steering and drive command signals are accurately carried out. The control module 20 also sends commands to solenoid actuated valve 26 in order to control the dispensing of paint through nozzle 29 onto turf 5 beneath the carriage 1.

FIG. 3 is a rear view of the carriage of FIG. 2 viewed along arrow A, with 10 battery 18B removed. In another embodiment of the invention, the tracking prism 2 and dispenser nozzle 29 may be mounted on a gimbal structure whereby the prism may be maintained vertically above the nozzle, even when the carriage is required to traverse an inclined surface, such as that illustrated in FIG. 7. This arrangement facilitates use of a taller mast 23 for carrying the tracking prism 2, better suited to 15 operation of the carriage 1 on sloping or undulating surfaces. If required, an inclinometer may be employed on the carriage. The inclinometer may be used either to automatically maintain the mast in a vertical orientation, or to transmit inclination data to the processor for real-time compensation of carriage inclination.

Referring now to FIG. 4, there is depicted a flow chart of a process 30 coded 20 into the software product executed by the processor of computer 8 in FIG. 1. The software product contains instructions to implement each of the steps of FIG. 4 of the procedure that will now be described. It will be realised that the actual coding of the instructions is straightforward for persons skilled in this field, once the functionality of the software product is explained.

25 At step 32 the communication ports used by computer 8 to communicate with base station 6 and radio transmitter 11 are opened and tested.

At step 34 a pre-stored "map" file 9 (see FIG. 5) containing point coordinates defining the logo to be demarcated by carriage 1 is opened.

At step 36 a command to start the carriage moving forward is generated. The 30 command is sent to transmitter 11 which in turn converts it to a radio frequency control signal that is transmitted to carriage 1. The carriage receives the signal by means of antenna 16, generates a corresponding baseband signal by means of receiver 15 and passes the baseband signal to control electronics module 20. The

control module generates corresponding commands that are sent to drive modules 22A-22D in order to start the carriage moving forwards.

At step 38 the computer reads the next point from the map file and sets it to be the current point for processing. At step 40 the computer reads carriage position data from base station 6. At step 44 the computer compares the data read at step 38 with the data read at step 40. If the two points are not within a small distance of each other then the computer decides that the carriage is not at the point dictated by the map coordinate. Consequently, at step 48 the direction vector from the carriage to the desired map coordinate is calculated.

At step 52 the velocity vector of the carriage is calculated. At step 54 the difference between the direction vector and the velocity vector is determined in order to generate a turn command to turn the carriage so that it heads towards the map point. Control then diverts to step 40 and steps 40 to 54 are repeated until it is determined at decision point 44 that the carriage and the current map point are sufficiently close enough for it to be said that the carriage is at the current map point. If they are sufficiently close control diverts to step 46.

At step 46 a mark command is generated causing a paint drop to be dispensed through nozzle 29.

At decision point 42 the computer checks if the current point of the map file is the last point in the file. In the event that it is the last point then the procedure ends at step 50. Alternatively, control passes back to step 38 and the previous procedure is repeated until all the points of the map file have been processed.

With reference to FIG. 5 there is shown a block diagram of many of the components of the previously described system showing the flow of information enabling positioning of the carriage and dispensing of paint as previously described.

Apart from turf marking, the carriage 1 may also be used as a surveying tool in which mode it is run back and forth over a surface to be surveyed. The procedure is suitably as follows:

- Initially a path is defined for the carriage to follow. The path may be defined in the same way as setting a path for marking. Normally the path will consist of parallel evenly spaced lines covering the surface in question.
- The carriage is then set up and commanded to follow the path.

- Each time the EDM equipment sends distance data to the computer it will also send the level or height of the carriage (Z coordinate) data. These levels or heights are stored in a file along with the corresponding latitude (X coordinate) and longitude (Y coordinate) position data.
- 5 The result is a data file defining a grid or points covering the area of interest that may be up-loaded to a computer-aided design (CAD) package for use in creating a digital terrain model (DTM). It will be appreciated that this survey procedure may be conveniently employed to create a DTM for the region of a surface desired to be marked.
- 10 Although not essential to operation, feedback sensors such as shaft encoders, a compass and/or an inclinometer may be included on the carriage 1. Data from the feed back sensors may be transmitted back to computer 8 by means of an additional radio frequency (RF) link. The software program may contain instructions to process the received feedback data in order to modify the control signals transmitted thereby
- 15 implementing a feedback control loop in order to minimise divergence of the carriage's path from the map coordinates.

Where an on-board computer is incorporated, the carriage guidance system may be arranged to transmit a desired direction bearing to the carriage. A processor on the carriage calculates the carriage's actual bearing as sensed by the compass

20 and compares it to the desired bearing in order to generate commands to steer the carriage along the desired bearing. The carriage guidance system also sends the carriage signals to control speed and to dispense paint. Accordingly in this embodiment two separate computer programs work together.

While the invention has been described as making use of an electronic

25 distance measuring apparatus in the form of a laser base station, it is possible to use other apparatus for determining the position of the carriage. For example, a global positioning system (GPS) receiver might be used, together with differential correction as required. However, GPS data is typically limited to 20mm accuracy; whereas data derived from an EDM system as explained herein, typically achieves a minimum of

30 10mm accuracy and tighter tolerances are usually achieved than is the case with GPS. Additionally, GPS may not be used indoors or in any area where the view of the sky is limited, since direct line of sight to a minimum of four GPS satellites is

required for GPS to operate satisfactorily. This is a serious limitation in that it would prevent the turf marking carriage operating inside large sporting stadiums.

Accordingly, while the invention may make use of a GPS receiver in order to monitor the location of the carriage it is preferred that EDM technology of the type described herein is used.

A variation of the embodiment of FIG. 1 will be explained with reference to FIG. 6. In FIG. 6 the EDM base station 6 has been mounted on carriage 1 whereas prism 2 has been fixed in the turf at a predetermined reference position. In this embodiment computer 8 is incorporated inside carriage 1. The software program executed by the computer is very similar to that explained with reference to FIG. 4 except that it includes instructions to transform the position coordinate data to take into account the transposition of the base station and reflective prism 2. A control panel 7 for entering data into the computer is mounted on cover 3 and is accessible to an operator. In this further embodiment the radio transmitter 11 and radio receiver 14 and antenna 16 are unnecessary, and so are not present. Accordingly, if the further embodiment is employed variations in the height or attitude of the EDM stations must be compensated out. It will be appreciated that use of the marking apparatus on substantially flat ground will obviate the requirement for height data.

In FIG. 7 there is shown a corporate logo "STONEWOLF" 62 applied to the sloping surface of turf 64 in the vicinity of a green 66 on a golf course 60. It is anticipated that points providing an outline of the logo 62 may be automatically produced by a ground marking apparatus according to embodiment of the invention, allowing the negative image of the lettering to be in-filled by hand.

The automatic marking system of the invention allows the creation of logos which take environmental factors into account, including the undulations in the surface to receive the markings and the desired viewing positions for both audiences in attendance and television viewers. Ground slope angles can vary by up to 30%, such as in the case of golf course contours. In such circumstances, prior art methods do not provide a satisfactory result or are otherwise costly, time consuming and laborious.

It will of course be realised that the above description of marking turfed ground surfaces, such as sports fields, has been given only by way of illustrative example of the invention. All such modifications and variations thereto, as would be apparent to

persons skilled in the art such as marking the surface of a car-park or roadway, are deemed to fall within the broad scope and ambit of the invention as is described herein and set out in the accompanying claims.

CLAIMS

1. An automatic ground marking apparatus for marking level or undulating turf, said apparatus including:

- 5 a carriage responsive to carriage control signals for traversing the ground, the carriage having a controllable steering and drive system and a controllable marking system;
- a position determining system arranged to determine the position of the carriage; and
- 10 a processor responsive to the position determining system and operatively executing a software product for generating said carriage control signals to cause the carriage to mark out a predetermined sign on the ground.

2. The automatic ground marking apparatus of claim 1 wherein the
15 carriage control signals are transmitted to the carriage from a remote processor, which processor is associated with points defining the predetermined sign.

3. The automatic ground marking apparatus of claim 1 wherein the position determining system comprises laser based electronic distance measuring
20 equipment including a base station and a reflector.

4. The automatic ground marking apparatus of claim 3 wherein the base station and the processor are mounted to the carriage, and said processor is connected to receive position data from the base station.

25 5. The automatic ground marking apparatus of claim 3 wherein the base station is fixed to the ground and the reflector is mounted to the carriage.

30 6. The automatic ground marking apparatus of claim 5 wherein the marking apparatus further includes a radio link to relay carriage control signals to the carriage from the processor.

7. The automatic ground marking apparatus of claim 1 wherein the controllable steering and drive system further incorporates an on-board compass with further processing apparatus responsive to the compass and arranged to determine an actual bearing of the carriage.

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8. The automatic ground marking apparatus of claim 7 wherein the further processing apparatus compares the actual bearing with a desired bearing encoded in the carriage control signals.

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9. The automatic ground marking apparatus of claim 1 wherein the controllable marking system includes a reservoir and dispensing nozzle for a marking medium.

15

10. The automatic ground marking apparatus of claim 9 wherein a controllable valve interconnects the reservoir and dispensing nozzle.

11. The automatic ground marking apparatus of claim 1 wherein the controllable steering and drive system includes a number of independently controllable drive units each coupled to a corresponding wheel of the carriage.

20

12. The automatic ground marking apparatus of claim 11 wherein the carriage further includes a feedback sensor arranged to provide a feedback signal to the processor.

25

13. The automatic ground marking apparatus of claim 1 wherein the carriage further includes an inclinometer for determining the attitude of the carriage.

30

14. The automatic ground marking apparatus of claim 13 wherein the inclinometer is coupled to a gimbal structure carrying a mast for a reflector and a marking means, wherein the inclinometer is arranged to maintain the mast in a vertical orientation.

15. A computer software product stored on a computer readable memory and executable by a processor for causing a carriage including a controllable steering and drive system and a controllable marking system, to mark out a sign on a ground surface, the software product including:

- 5 carriage position instructions for reading a carriage position from a data stream generated by a position sensing device;
- sign point instructions for reading a file of points defining a predetermined sign;
- command instructions for generating commands to cause a carriage to dispense paint on the surface in order to mark out said sign.

16. A method for marking undulating turf employing the apparatus of claim 1, said method including the steps of:

- surveying a region of ground by means of an automated carriage arranged to move over a predetermined path by -
 - initiating movement of the carriage over the path,
 - monitoring the position of the carriage, and
 - recording position coordinates of the carriage in a computer file for producing a digital terrain map;
- 20 creating a file of points defining a predetermined sign using the file of recorded position coordinates; and
 - processing the file of points to generate control signals to cause the carriage to traverse the ground and mark out said sign.

- 25 17. The marking method of claim 16 wherein the control signals are transmitted to the carriage in real time.

18. The marking method of either claim 16 or claim 17 wherein the step of creating a file of points takes account of desired viewing positions for the sign.

- 30 19. The marking method of claim 16 wherein the position of the carriage is monitored from a remote site.

20. The marking method of claim 16 wherein the position of the carriage is monitored from a position sensing device on-board the carriage.

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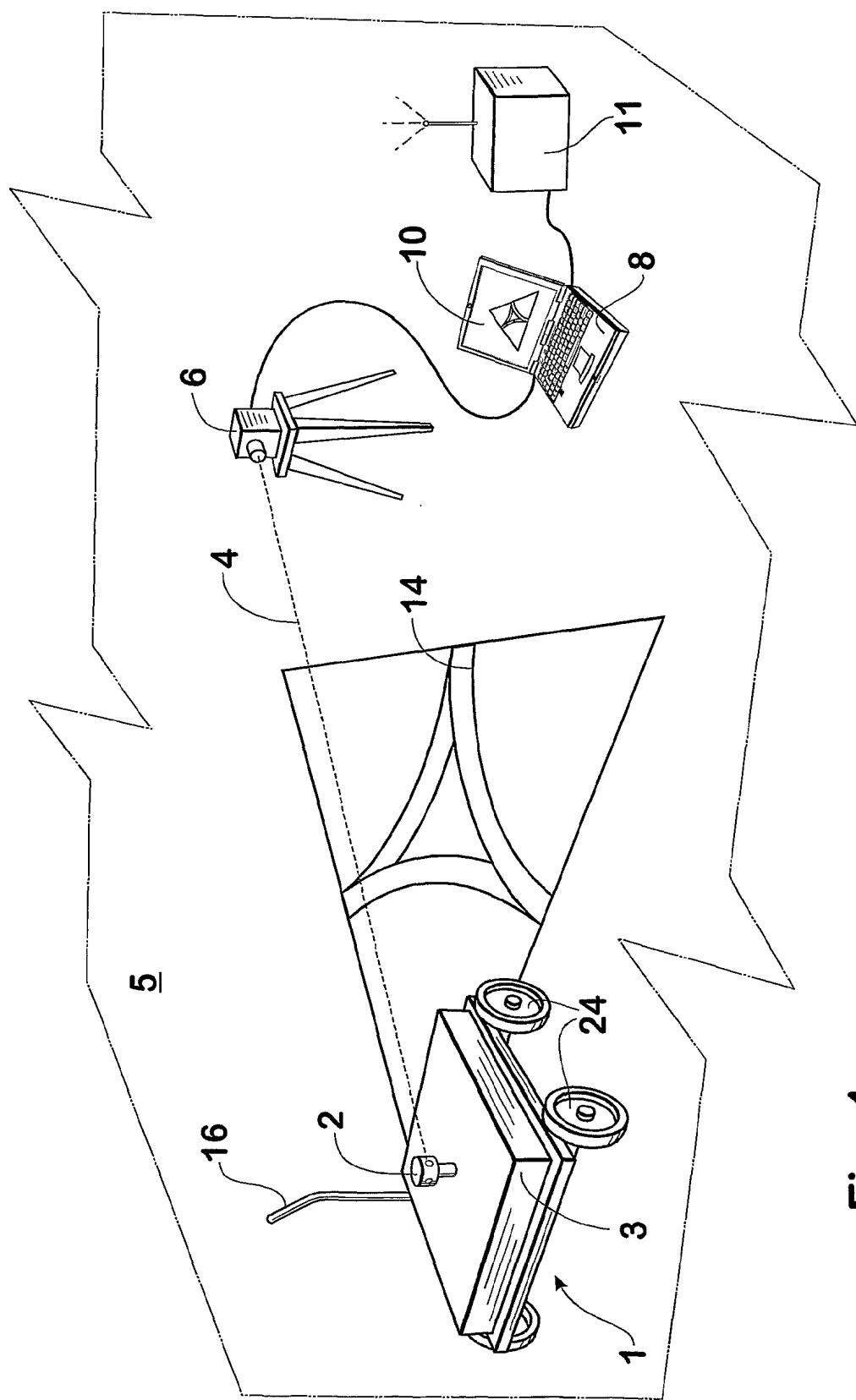


Fig. 1

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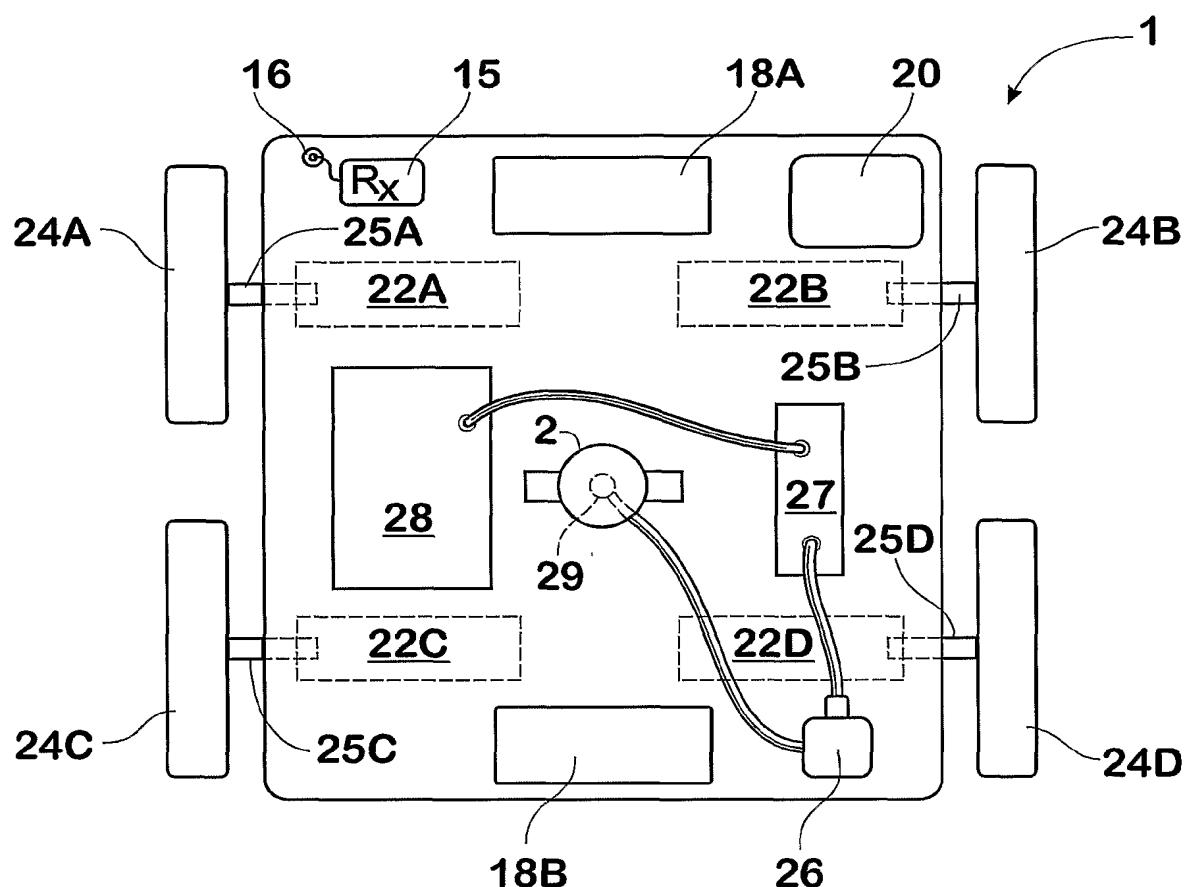


Fig. 2

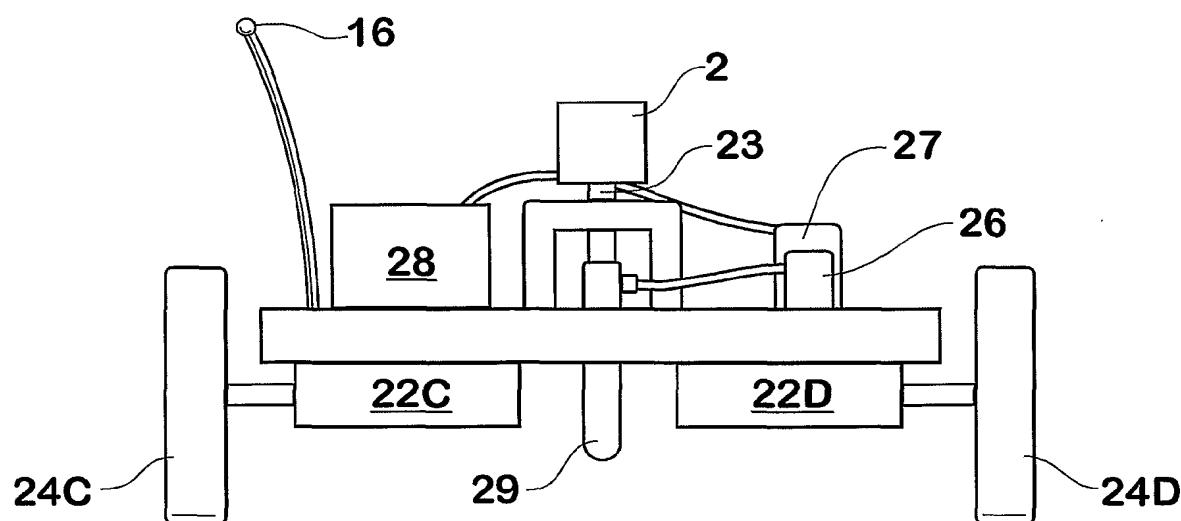


Fig. 3

3 / 5

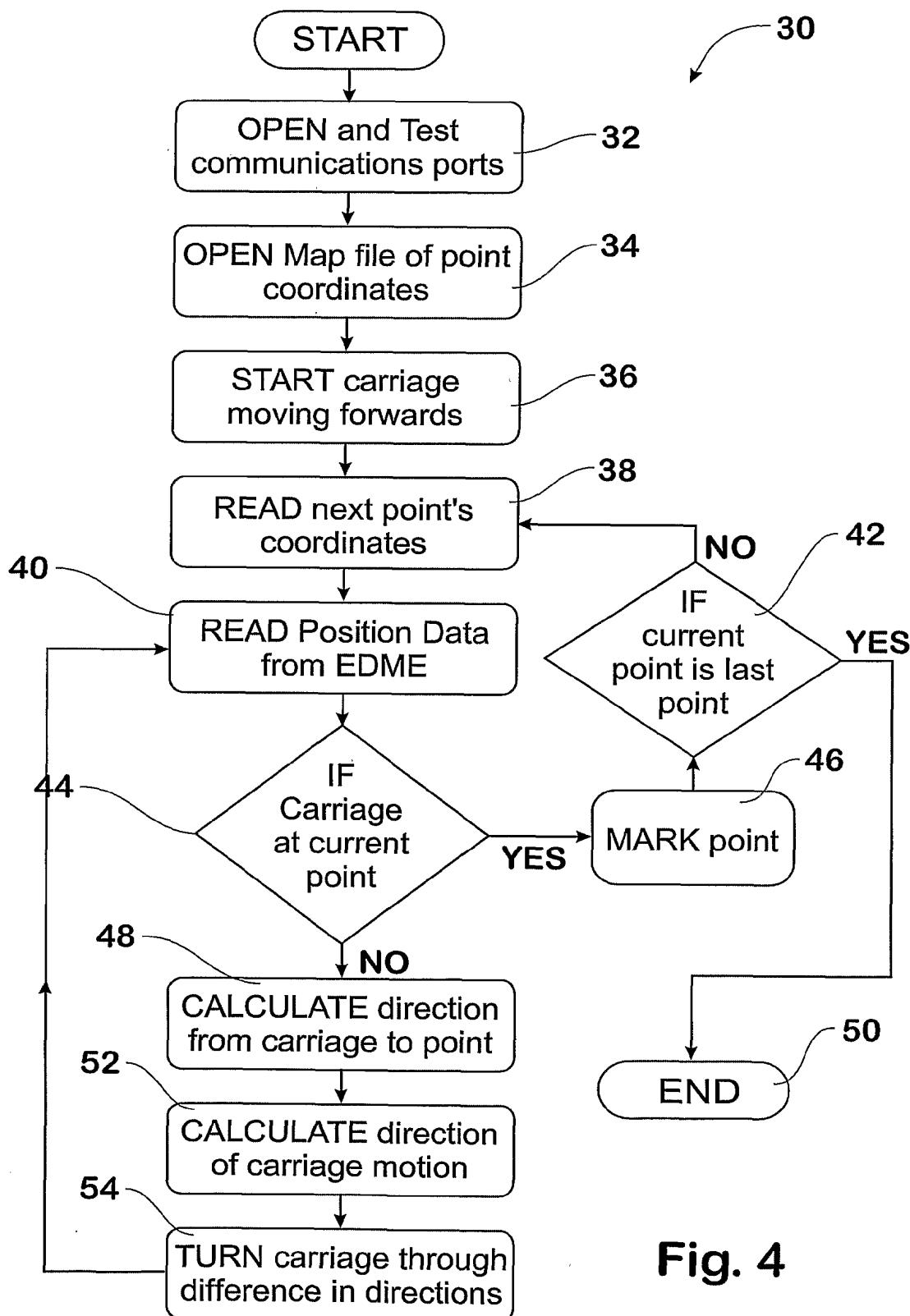


Fig. 4

4 / 5

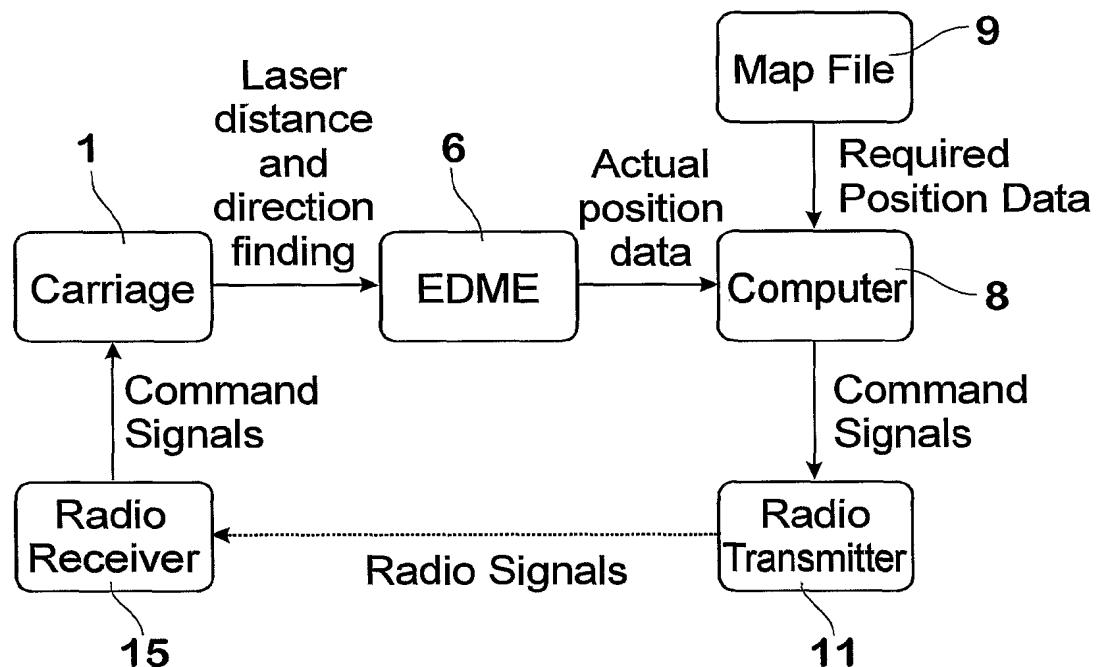


Fig. 5

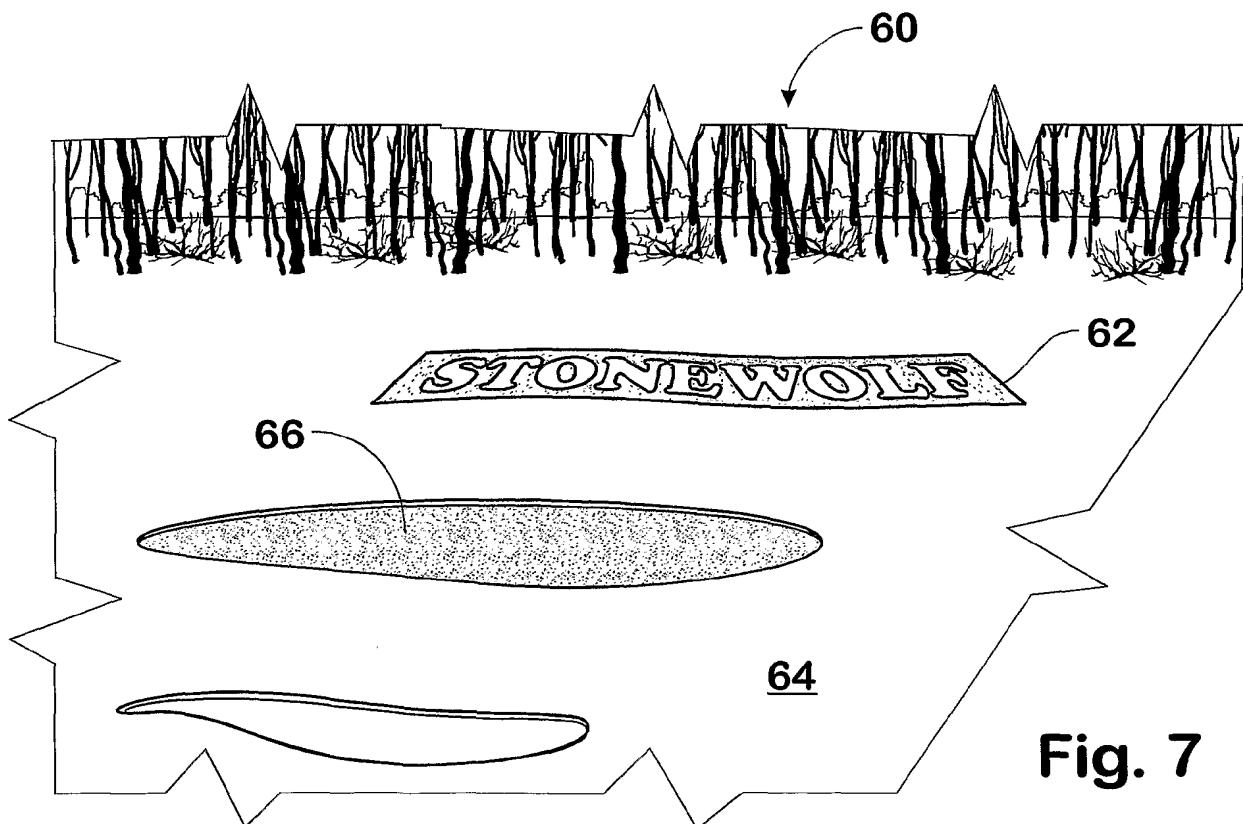


Fig. 7

5 / 5

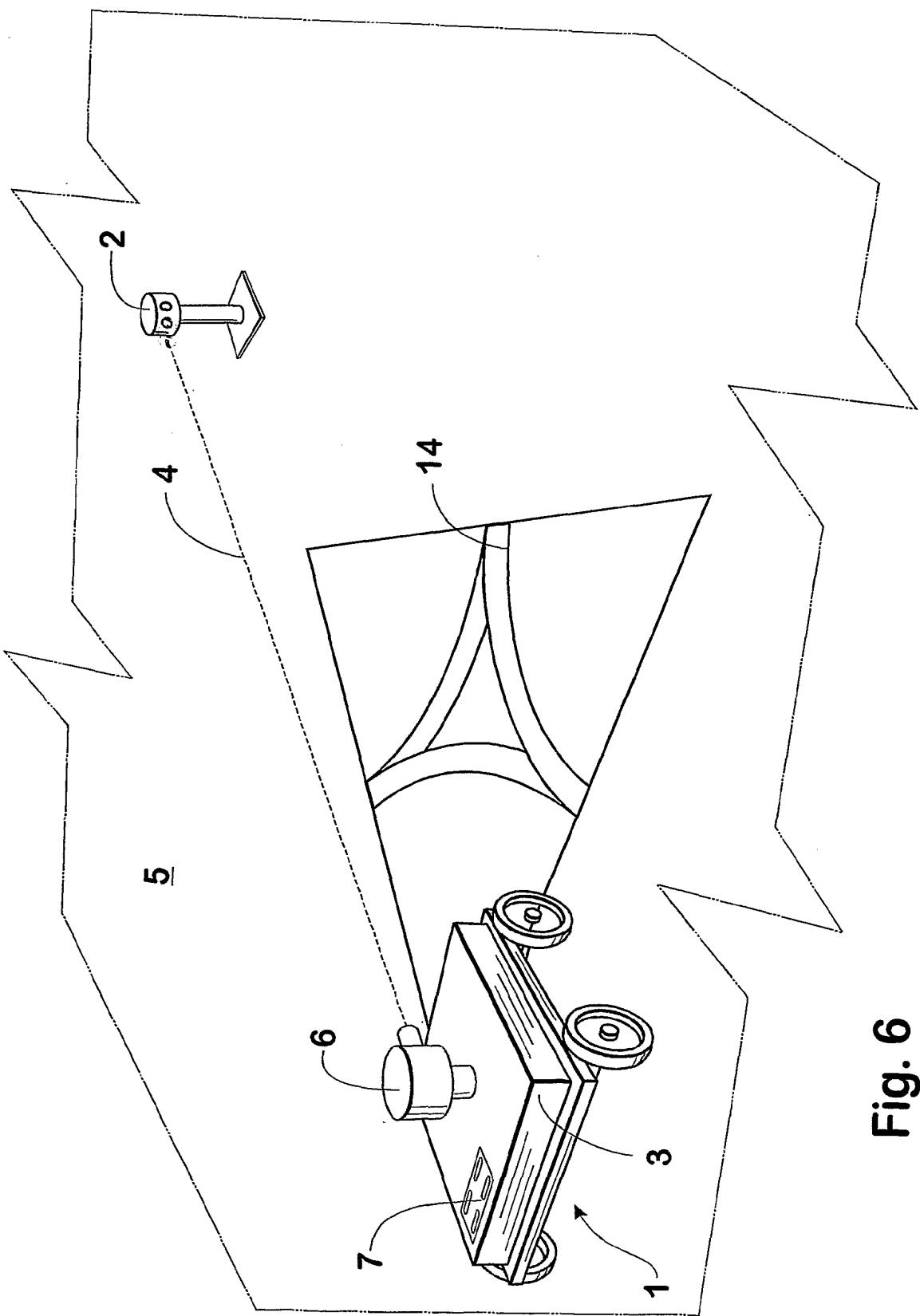


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU02/00357

A. CLASSIFICATION OF SUBJECT MATTERInt. Cl.⁷: A63C 19/06, 19/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DWPI: IPC A63C 19/00, 19/06, 19/08 & keywords: (remote, automatic, processor, program, signal, pulse, input, software, carriage, cart, position, location, bearing, measure, mark, paint, determine, outline) and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5540516 A (NICODEMO et al) 30 July 1996 Whole document	1-20
X	GB 2266863 A (THOMPSON) 17 November 1993 Whole document	1-20
X	Derwent Abstract Accession No 96-110641/12, Class Q41, JP 08010379 A (NIPPON KOKU DENSI II KOGYO KK) 16 January 1996 Abstract	1-20

Further documents are listed in the continuation of Box C See patent family annex

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search 17 April 2002	Date of mailing of the international search report - 6 JUN 2002
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer A. ALI Telephone No : (02) 6283 2607

INTERNATIONAL SEARCH REPORT

International application No. PCT/AU02/00357
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C (Continuation).		DOCUMENTS CONSIDERED TO BE RELEVANT
Category*	Citation of document, with indication, where appropriate, of the relevant passages	
		Relevant to claim No.
X	WO 97/18021 A (ATHAR INTERNATIONAL SERVICES) 22 May 1997 Whole document	1-20
A	WO 89/12484 A (AUBUSSON) 28 December 1989 Abstract	15
A	DE 19738605 A (HARDER) 11 March 1999 Abstract	15
A	Derwent Abstract Accession No 96-203451/21, Class P36, JP 08071201 A (PILOT CORP) 19 March 1996 Abstract	
A	GB 2164376 A (SISIS EQUIPMENT (MACCLESFIELD) LIMITED UK) 19 March 1986 Whole document	

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU02/00357

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member			
US	5540516	AU	68641/94	EP	636393	PL	304453
		GB	9402941	CN	1102353	JP	7152336
		CZ	9401805				
GB	2266863		NONE				
JP	08010379		NONE				
WO	97/18021	AU	72763/96				
WO	89/12484	AU	39673/89	EP	423218		
DE	19738605	AU	10215/99	EP	1017453	WO	99/11328
JP	08071201	DE	3048985	GB	2069168		
GB	2164376		NONE				

END OF ANNEX

INTERNATIONAL SEARCH REPORTInternational application No.
PCT/AU02/00357**Box I Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos :
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos :
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos :
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. Claims 1-14, 16-20
2. Claim 15

As reasoned on the extra sheet:

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims
2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest The additional search fees were accompanied by the applicant's protest. No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU02/00357**Supplemental Box**

(To be used when the space in any of Boxes I to VIII is not sufficient)

Continuation of Box No: II

The international application does not comply with the requirements of unity of invention because it does not relate to one invention or to a single inventive concept. The **International Searching Authority** has found that there are different inventions as follows:

1. Claims 1-14 and 16-20 are directed to an automatic ground marking apparatus and a method, for marking level or undulating turf. It is considered that the carriage responsive to carriage control signals, the position determining system and the processor comprise a first "special technical feature".
2. Claim 15 is directed to a computer software product. It is considered that the instructions in the computer software and executable by a processor comprise a second "special technical feature".

Since the above mentioned groups of claims do not share any of the technical features identified, a "technical relationship" between the inventions, as defined in PCT rule 13.2 does not exist. Accordingly the international application does not relate to one inventive concept, **a priori**.